IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appeal No. ________________

Application No.: 10/693,787

Filing Date: 10/24/2003

Appellant: Sehat Sutardja

Group Art Unit: 2838

Examiner: Rajnikant B. Patel

Title: VOLTAGE REGULATOR

Attorney Docket: MP0400

APPEAL BRIEF

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May 4, 2009

Sir:

This brief on appeal is submitted pursuant to the Notice of Appeal filed in the U.S. Patent and Trademark Office on March 3, 2009, and from the decision of the Patent Examiner dated December 3, 2008, rejecting claims 1-23, 75-97, 155-172, 187, 188 and 240-243 as set forth in the Final Action mailed December 3, 2008.

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I. REAL PARTY IN INTEREST

The real party in interest is Marvell World Trade Ltd. by virtue of assignments recorded in the Patent and Trademark Office at Reel 014661, Frame 0024.

II. RELATED APPEALS AND INTERFERENCES

The Assignee, the Appellant, and the undersigned do not know of any other appeals, interferences, or judicial proceedings that would directly affect or that would be directly affected by, or have a bearing on, the Board's decision in this Appeal.

III. STATUS OF THE CLAIMS

Appellant appeals the rejection of claims 1-23, 75-97, 155-172, 187, 188 and 240-243.

Claims 1-23, 75-97, 155-172, 187, 188 and 240-243 are rejected.

Claims 24-74, 98-154, 173-186, and 189-239 are cancelled.

IV. STATUS OF THE AMENDMENTS

The claims have not been amended subsequent to the final rejection, and there are no un-entered amendments.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

Appellant notes that Page numbers in the Application and in this Brief begin following the Cover Page that was filed with the Application.

Independent claim 1 recites a coupled inductor regulator (e.g., coupled-inductor regulator 10, FIG. 1A; see Page 6, Lines 19-21) for converting energy from a source of input voltage to an output having an output voltage (Id.). The coupled inductor regulator includes at least two conduction switches (e.g., conduction switches 11, FIG. 1A; see Page 7, Lines 5-6) to conduct energy from the source of input voltage to the output (Id.). The coupled inductor regulator also includes at least two inductors (e.g., coupled inductors 13, FIG. 1A; Page 7, Lines 6-7) in communication with the at least two conduction switches, the at least two inductors wound together on a common core and each inductor having a polarity such that DC currents in the inductors cancel each other (e.g., FIG. 2B; see Page 8, Lines 12-15), the inductors having a coefficient of coupling approximately equal to one (e.g., FIG. 2B; see Page 8, Lines 5-7). The coupled inductor regulator also includes at least two freewheeling switches (e.g., freewheeling switches 12, FIG. 1A; see Page 7, Line 6) in communication with the at least two conduction switches to provide a path for current during non-conduction (e.g., FIG. 2B; see Page 12, Lines 4-7). The coupled inductor regulator also includes a drive signal generator (e.g., drive signal generator 14; see Page 7, Lines 8-9) to generate drive signals each having a duty cycle of approximately 50%, the drive signals to control the at least two conduction switches (e.g., FIG. 17A; Page 31, Lines 5-14).

Independent claim 75 recites a coupled inductor regulator (e.g., coupled-inductor regulator 10, FIG. 1A; see Page 6, Lines 19-21) for converting energy from a source of input voltage to an output having an output voltage (Id.). The coupled inductor regulator includes at least two means for conduction switching (e.g., conduction switches 11, FIG. 1A; see Page 7, Lines 5-6) to controllably conduct energy from the source of input voltage to the output. The coupled inductor regulator also includes at least two inductors (e.g., coupled inductors 13, FIG. 1A; Page 7, Lines 6-7) in communication with the at least two means for conduction switching. The at least two inductors are wound together on a common core and each inductor having a polarity such that DC currents in the inductors cancel each other (e.g., FIG. 2B; see Page 8, Lines 12-15). The inductors have a coefficient of coupling approximately equal to one (e.g., FIG. 2B; see Page 8, Lines 5-7). The coupled inductor regulator also includes at least two means for freewheeling switching (e.g., freewheeling switches 12, FIG. 1A; see Page 7, Line 6) in communication with the at least two conduction switching means to provide a path for current during non-conduction periods (e.g., FIG. 2B; see Page 12, Lines 4-7). The coupled inductor regulator also includes means for generating drive signals (e.g., drive signal generator 14; see Page 7, Lines 8-9), the drive signals each having a duty cycle of approximately 50%, and the drive signals to control the at least two conduction switching means (e.g., FIG. 17A; Page 31, Lines 5-14).

Independent claim 155 recites a coupled inductor regulator (e.g., coupled-inductor regulator 10, FIG. 1A; see Page 6, Lines 19-21) for converting energy from a source of input voltage to an output having an output voltage (Id.). The coupled inductor

regulator includes at least two phase signals to control a conduction time (e.g., FIGs. 1A-1B; see Page 9, Lines 8-16). The coupled inductor regulator also includes at least two drivers (e.g., conduction switches 11, FIG. 1A; see Page 7, Lines 5-6), responsive to the at least two phase signals, to conduct energy from the source of input voltage. The coupled inductor regulator also includes a lattice network of coupled inductors (e.g., coupled inductors 13, FIG. 1A; Page 7, Lines 6-7) in communication between the at least two drivers and the output, the lattice network (e.g., lattice network generally shown in FIG. 16C; see Page 20, Lines 17-24) having N stages wherein N is at least one. Pairs of inductors within each of the stages each having a coefficient of coupling approximately equal to one (e.g., FIG. 16A; see Page 19, Lines 9-10). The coupled inductor regulator also includes the phase signals each having a duty cycle of approximately 100%/2N (e.g., FIG. 16C; see Page 21, Lines 3-4). The coupled inductor regulator also includes the output voltage approximately equal to the input voltage divided by 2N (e.g., FIG. 16C; see Page 20, Lines 22-24).

Independent claim 164 recites a coupled inductor regulator (e.g., coupled-inductor regulator 10, FIG. 1A; see Page 6, Lines 19-21) for converting energy from a source of input voltage to an output having an output voltage (Id.). The coupled inductor regulator includes at least two phase signals to control a conduction time (e.g., FIGs. 1A-1B; see Page 9, Lines 8-16). The coupled inductor regulator also includes at least two means for conducting (e.g., conduction switches 11, FIG. 1A; see Page 7, Lines 5-6), responsive to the at least two phase signals, to conduct energy from the source of input voltage (e.g., FIG. 2B;

see Page 12, Lines 4-7). The coupled inductor regulator also includes a lattice network of coupled inductors (e.g., coupled inductors 13, FIG. 1A; Page 7, Lines 6-7) in communication between the at least two means for conducting and the output. The lattice network has N stages, where N is at least one (Id.). Pairs of the coupled inductors within each of the stages each have a coefficient of coupling approximately equal to one (e.g., FIG. 16A; see Page 19, Lines 9-10). The coupled inductor regulator also includes the phase signals each having a duty cycle of approximately 100%/2N (e.g., FIG. 16C; see Page 21, Lines 3-4). The coupled inductor regulator also includes the output voltage approximately equal to the input voltage divided by 2N (e.g., FIG. 16C; see Page 20, Lines 22-24).

Dependent claim 188 recites that the at least two conduction switches include a first conduction switch that receives a first drive signal and a second conduction switch that receives a second drive signal (e.g., conduction switches 11, FIGs. 1A-1B; see Page 7, Lines 5-6 and Page 9, Lines 8-12). The at least two freewheeling switches include a first freewheeling switch that receives the second drive signal and a second freewheeling switch that receives the first drive signal (e.g., freewheeling switches 12, FIG. 1A; see Page 7, Line 6). The first and second drive signals are the same signal with a phase offset that is equal to 360 degrees divided by a number of the conduction switches (e.g., FIGs.16A-16C; see Page 19, Lines 1-9).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Appellant seeks the Board's review of:

(a) whether claims 1 and 75 are unpatentable under 35 U.S.C. § 102(b) over U.S. Patent No. 6,084,790 ("Wong").

(b) whether claims 2-23, 76-97, 187-188 and 240-243 are unpatentable under 35 U.S.C. § 103(a) over Wong in view of U.S. Patent No. 5,821,832 ("Moreau") and U.S. Patent No. 5,402,329 ("Wittenbreder") and further in view of U.S. Patent No. 6,493,242 ("Riggio").

(c) whether claims 155-172 are unpatentable over Wong in view of Moreau, Wittenbreder and further in view of U.S. Patent No. 3,529,233("Podell").

VII. ARGUMENTS

A. Rejection under 35 U.S.C. § 102(b) over U.S. Pat. No. 6,084,790 ("Wong")

1. Claims 1 and 75

Independent claim 1 recites a coupled inductor regulator for converting energy from a source of input voltage to an output having an output voltage. The coupled inductor regulator includes at least two conduction switches to conduct energy from the source of input voltage to the output. The coupled inductor regulator also includes at least two inductors in communication with the at least two conduction switches. The at least two inductors are wound together on a common core and each inductor having a polarity such that DC currents in the inductors cancel each other. The inductors also have a coefficient of coupling approximately equal to one. The coupled inductor regulator also includes at least two freewheeling switches in communication with the at least two conduction switches to provide a path for current during non-conduction. The coupled inductor regulator also includes a drive signal generator to generate drive signals each having a duty cycle of approximately 50%, the drive signals to control the at least two conduction switches.

(a) Wong fails to disclose two inductors wound together on a common core, each inductor having a polarity such that DC currents in the inductors cancel each other, as recited in claim 1

In rejecting claim 1, the Examiner alleges that Wong discloses all the elements of claim 1. The Examiner does not explicitly point out where Wong discloses two inductors wound

together on a common core, each inductor having a polarity such that DC currents in the inductors cancel each other (see Pages 2-3 of the Final Office Action dated December 3, 2008, hereinafter "the Office Action"). The Examiner, however, asserts that FIG. 5 of Wong (provided below) discloses the features claim 1 (Page 2 of the Office Action).

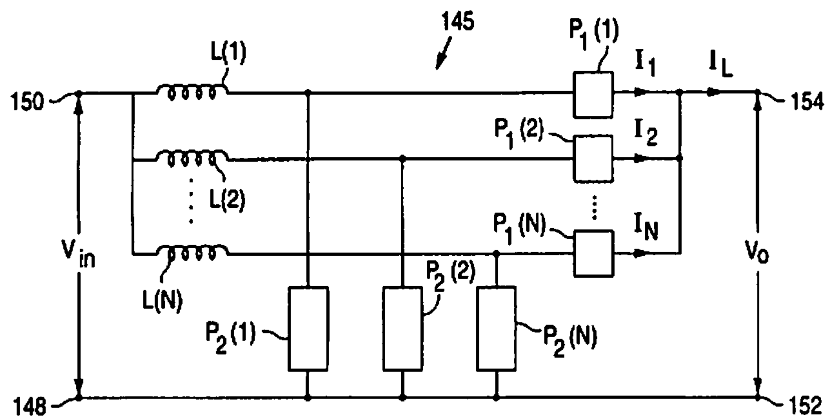

FIG. 5

Appellant respectfully notes that FIG. 5 of Wong and the corresponding description do not disclose two inductors wound together on a common core, each inductor having a polarity such that DC currents in the inductors cancel each other, as claim 1 recites. Instead, FIG. 5 of Wong discloses only <u>inductors L1-LN that are not wound around a common core</u>. Because the inductors L1-LN are not wound around a common core, inductors L1-LN cannot each have a polarity such that DC currents in the inductors cancel each other.

The Examiner does not discuss portions of Wong that describe inductors that could be wound together, such as shown in FIG. 8 of Wong (provided below).

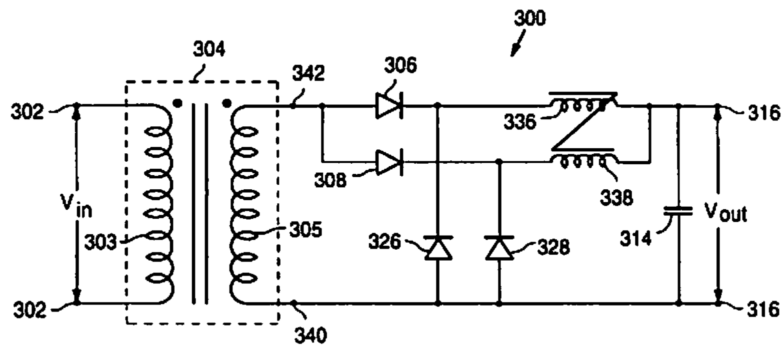

FIG. 8

However, as is clear in FIG. 8 and the related disclosure, the inductors of FIG. 8 of Wong have matching polarities and do not each have a polarity such that DC currents in the inductors cancel each other, as claim 1 recites.

FIG. 8 of Wong, as best understood by Appellant, teaches a typical transformer system that includes a voltage regulator to regulate voltage on a primary winding side 303 and an output receiving the transformed voltage on a secondary winding side 305. The primary and secondary windings have matching polarities that do not cancel each other.

The Court of Appeals for the Federal Circuit has recently stated: "We thus hold that unless a reference discloses within the four corners of the document not only all of the limitations claimed but also all of the limitations arranged or combined in the same way as recited in the claim, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. §102… [D]ifferences between the prior art reference and a claimed invention, however slight, invoke the question of obviousness, not anticipation." _Net MoneyIN Inc. v. VeriSign Inc._, 88 USPQ2d 1751, 1759-1760 (Fed. Cir. 2008). Wong does not disclose two inductors wound together on a common core, each inductor having a polarity such that DC currents in the inductors cancel each other.

Claim 1 is therefore allowable for at least this reason.

(b) Wong fails to disclose a coefficient of coupling equal approximately to one, as recited in claim 1

In rejecting claim 1, the Examiner alleges that a coefficient of coupling equal approximately to one is "a inherent properties of couple inductor" (Page 3 of the Office Action). The Examiner further references FIG. 5 as including all the elements of claim 1 (Id.). Appellant disagrees.

Wong does not disclose coefficient of coupling, and therefore the Examiner attempts to make up for this deficiency by an assertion that this element is an inherent property of coupled inductors. The Examiner provides no support for his broad assertion of inherency. In other words, the Examiner admits that the element is absent in Wong and attempts to use general knowledge in the art to support his position.

However, the Court of Appeals for the Federal Circuit has recently stated: "We thus hold that unless a reference discloses <u>within the four corners of the document not only all of the limitations claimed but also all of the limitations arranged or combined in the same way as recited in the claim</u>, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. §102… [D]ifferences between the prior art reference and a claimed invention, however slight, invoke the question of obviousness, not anticipation." <u>*Net MoneyIN Inc. v. VeriSign Inc.*</u>, 88 USPQ2d 1751, 1759-1760 (Fed. Cir. 2008) (emphasis added). Wong does not disclose a coefficient of coupling equal approximately to one. The Examiner's inherency argument, at best supports a rejection based on obviousness, not anticipation.

FIG. 5 of Wong, as provided above, shows inductors L1-LN that are not wound around common cores, and therefore, the inductors L1-L5 do not have coefficients of coupling between them. Therefore, Wong clearly does not disclose a coefficient of coupling equal approximately to one. As to this feature being inherent, coefficient of coupling generally refers to a relationship between coupling of two inductors (see e.g. Coupling Coefficient, IEEE 100: The Authoritative Dictionary of IEEE standard Terms, 7th ed. (2000)). Thus, a coefficient of coupling may have a wide array of values.

The inductors of FIG. 5, which the Examiner asserts is the most relevant portion of Wong, are not wound together, and thus do not have a coefficient of coupling between them. However, even if they were wound together, no reason is provided why a coefficient of coupling equal approximately to one would be selected, outside of the Examiner's broad assertions. This element is simply not disclosed in the reference. Typical coupled inductors have a broad array of coefficients of coupling. Thus, a coefficient of coupling that is approximately equal to one is not inherent. Therefore, not only is claim 1 allowable over Wong on the grounds of anticipation, claim 1 is also allowable over Wong on the grounds of obviousness (even though such a rejection has not been asserted).

Claim 1 is therefore allowable for at least this reason.

(c) Other claims

Independent claim 75 includes similar limitations and is therefore allowable for at least similar reasons as claim 1.

B. Rejection under 35 U.S.C. § 103(a) over U.S. Pat. No. 6,084,790 ("Wong") in view of U.S. Pat. No. 6,084,790 ("Moreau") and U.S. Pat. No. 5,821,832 ("Wittenbreder") and further in view of U.S. Pat. No. 6,493,242 ("Riggio")

1. Claims 2-23, 76-97, 187 and 240-243

Moreau, Wittenbreder and Riggio do not remedy the deficiencies of Wong with respect to claims 1 and 75, from which claims 2-23, 76-97, 187 and 240-243 depend. Therefore, claims 2-23, 76-97, 187 and 240-243 are in condition for allowance for at least similar reasons as claims 1 and 75.

Appellant's position with respect to claims 2-23, 76-97, 187 and 240-243 should not be understood as implying that no other reasons for the patentability of claims 2-23, 76-97, 187 and 240-243 exist. Appellant reserves the right to address these other reasons at a later date if needed.

2. Claim 188

Dependent claim 188 recites that a first conduction switch receives a first drive signal and a second conduction switch receives a second drive signal. A first freewheeling switch receives the second drive signal and a second freewheeling switch receives the first drive signal. The first and second drive signals are the same signal with a phase offset that is equal to 360 degrees divided by a number of the conduction switches.

(a) Wong fails to disclose first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches, as recited in claim 188

As a preliminary matter, Appellant could not determine where the Examiner pointed out portions of Wong, Moreau, Wittenbreder and Riggio that disclose first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches. Further, Appellant has carefully reviewed the references and still fails to find first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches.

As best understood by Appellant, Wong includes a set of power devices/switches that "<u>are operated in phase</u> so as to provide equal current sharing between the set of N power devices." Column 5, Lines 1-3 of Wong (emphasis added). In contrast, the drive signals of claim 188 drive switches out of phase with a phase offset that is equal to 360 degrees divided by a number of conduction switches.

Because Wong drives power devices/switches in phase, drive signals of Wong do not drive the power devices/switches at a predetermined phase offset. Therefore, Wong does not disclose first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches.

Further, Wong teaches away from this feature. Wong includes a set of power devices/switches that are operated in phase. Column 5, Lines 1-3 of Wong. Wong teaches control of the switches in phase to ensure equal current sharing between parallel power devices. Column 1, Lines 1-7 of Wong. Were the switches of Wong to be controlled out of phase as the Examiner proposes, Wong would fail to ensure equal current sharing

between parallel power devices and would instead divide the current so that various branches do not equally share current.

Therefore, not only does Wong teach power devices/switches that are operated in phase, Wong also teaches that it is desirable to operate the power devices/switches in phase. Therefore, Wong teaches away from first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches.

A reference must be considered for all that it teaches including disclosures that point towards the invention and disclosures that teach away from the invention. *In re Dow*, 5 USPQ.2d' 1529 (Fed. Cir. 1988). It is improper to take teachings in the prior art out of context and give them meanings that they would not have to those skilled in the art. *In re Wright*, 9 USPQ.2d 1649 (Fed. Cir 1989). It is impermissible to pick and choose from a reference in an attempt to support a given position to the exclusion of other essential parts of what the reference fairly teaches to one skilled in the art. *Bausch & Lomb, Inc. v. Barnes-Hind, Inc.*, 230 USPQ 416 (Fed. Circ. 1986). "(W)hen the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be non-obvious." *KSR Int'l v. Teleflex Inc.*, 127 S.Ct. 1727 (2007).

Wong teaches away from first and second drive signals that control switches and that have a phase offset that is equal to 360 degrees divided by a number of conduction switches and instead teaches controlling switches in phase.

Therefore, claim 188 is allowable for at least these additional reason.

(b) Wong, Moreau, Wittenbreder and Riggio fail to disclose first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches, as recited in claim 188

Moreau, Wittenbreder and Riggio fail to cure the deficiencies of Wong. For example, Moreau does not discuss switches or drive signals for switches. Therefore, Moreau cannot disclose drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches, as recited in claim 188.

Wittenbreder, on the other hand, discloses switches but does not control the switches with signals that have a phase offset of 360 degrees divided by the number of conduction switches. For example, Wittenbreder includes "a conventional timing circuit" that "controls the duty cycles of switches 206, 212, and 234" so that "switch 212 and switch 234 are turned off simultaneously" (see Column 6, Lines 50-65 of Wittenbreder). In other words, the switches 212, 234 of Wittenbreder are controlled in phase. Because switches 212, 234 of Wittenbreder are controlled in phase, Wittenbreder cannot disclose drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches, as recited in claim 188.

Still further, Riggio merely discloses a single switch controlled by a drive circuit that periodically provides control for an inductor. In other words, Riggio does not control switches with signals that have a phase offset of 360 degrees divided by the number of conduction switches because Riggio only controls one switch.

(c) The Examiner has failed to establish a prima facie case of obviousness

To establish a *prima facie* case of obviousness, the prior art references must teach or suggest all the claim limitations. See, e.g., *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Wong, Moreau, Wittenbreder and Riggio clearly fail to disclose first and second drive signals with a phase offset that is equal to 360 degrees divided by a number of conduction switches, as recited in claim 188.

Consequently, the combination of Wong, Moreau, Wittenbreder and Riggio cannot render claim 188 obvious.

In view of the foregoing, Appellant respectfully submits that claim 188 is in condition for allowance for at least the above reasons.

C. Rejection under 35 U.S.C. § 103(a) over Wong in view of Moreau and Wittenbreder, and further in view of Riggio and U.S. Pat. No. 3,529,233 ("Podell")

1. Claims 155-172

Moreau, Wittenbreder, Riggio and Podell do not remedy the deficiencies of Wong with respect to claim 1. Independent claims 155 and 164 are allowable for at least similar reasons as claim 1. Claims 156-163 and 165-172 depend from claims 155 and 164 and are therefore also in condition for allowance for at least similar reasons as claim 1.

Appellant's position with respect to claims 155-172 should not be understood as implying that no other reasons for the patentability of claims 155-172 exist. Appellant reserves the right to address these other reasons at a later date if needed.

CONCLUSION

Appellant respectfully requests the Board to reverse the Examiner's rejection of the claims on appeal.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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VIII. CLAIMS APPENDIX

This is a complete and current listing of the claims.

1. (Original) A coupled inductor regulator for converting energy from a source of input voltage to an output having an output voltage, comprising:

at least two conduction switches to conduct energy from the source of input voltage to the output;

at least two inductors in communication with the at least two conduction switches, the at least two inductors wound together on a common core and each inductor having a polarity such that DC currents in the inductors cancel each other, the inductors having a coefficient of coupling approximately equal to one;

at least two freewheeling switches in communication with the at least two conduction switches to provide a path for current during non-conduction periods; and

a drive signal generator to generate drive signals each having a duty cycle of approximately 50%, the drive signals to control the at least two conduction switches.

2. (Original) The coupled inductor regulator of Claim 1 wherein the coefficient of coupling is approximately at least 0.99.

3. (Original) The coupled inductor regulator of Claim 1 wherein the at least two conduction switches, the at least two inductors, and the at least two freewheeling switches are connected in a buck configuration such that the output voltage is approximately one-half the amplitude of the input voltage.

4. (Original) The coupled inductor regulator of Claim 3 wherein the buck configuration includes two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a conduction switch in communication with a freewheeling switch and an inductor, the conduction switch to communicate current during a conduction period from the source of input voltage through the inductor to the output, the freewheeling switch to provide a conduction path during the non-conduction period for current flowing through the inductor to the output.

5. (Original) The coupled inductor regulator of Claim 1 wherein the at least two conduction switches, the at least two inductors, and the at least two freewheeling switches are connected in a boost configuration such that the output voltage is approximately twice the amplitude of the input voltage.

6. (Original) The coupled inductor regulator of Claim 5 wherein the boost configuration includes two boost regulators each operating at approximately 50% duty cycle, each boost regulator including;

a conduction switch in communication with a freewheeling switch and an inductor, the conduction switch to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the freewheeling switch to provide a conduction path during the non-conduction period for current flowing from the high side of the source of input voltage through the inductor to the output.

7. (Original) The coupled inductor regulator of Claim 1 wherein the at least two conduction switches, the at least two inductors, and the at least two freewheeling switches are connected in a 1:-1 configuration such that the output voltage is approximately a negative of the input voltage.

8. (Original) The coupled inductor regulator of Claim 7 wherein the 1:-1 configuration includes two flyback regulators each operating at approximately 50% duty cycle, each flyback regulator including;

a conduction switch in communication with a freewheeling switch and an inductor, the conduction switch to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the freewheeling switch to provide a conduction path during the non-conduction period for current flowing from the output through the inductor to the low side of the source of input voltage.

9. (Original) The coupled inductor regulator of Claim 1 wherein at least one of the conduction switches includes independently controllable parallel switches.

10. (Original) The coupled inductor regulator of Claim 1 wherein the output voltage supplies power to a load; and

further comprising a frequency generator to generate a clock signal having an operating frequency, the drive signals synchronous to the clock signal, and the operating frequency controllable in response to changes in the load.

11. (Original) The coupled inductor regulator of Claim 10 wherein the changes in the load include output current changes and output voltage changes.

12. (Original) The coupled inductor regulator of Claim 1 wherein each of the at least two inductors includes a pair of series inductors, each pair having a common node between the series inductors; and

each of the conduction switches in communication with the common node of a corresponding pair of series inductors.

13. (Original) The coupled inductor regulator of Claim 12 wherein the at least two conduction switches, pairs of series inductors, and freewheeling switches are connected in a buck configuration, the buck configuration including two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a conduction switch in communication with a freewheeling switch and the pair of series inductors, the conduction switch to communicate current during a conduction period from the source of input voltage through the pair of series inductors to the output, the freewheeling switch to provide a conduction path during the non-conduction period for current flowing through one of the series inductors to the output.

14. (Original) The coupled inductor regulator of Claim 12 wherein the at least two conduction switches, the at least two

inductors, and the at least two freewheeling switches are connected in a boost configuration including two boost regulators each operating at approximately 50% duty cycle, each boost regulator including;

a conduction switch in communication with a freewheeling switch and an inductor, the conduction switch to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the freewheeling switch to provide a conduction path during the non-conduction period for current flowing from the high side of the source of input voltage through the inductor to the output.

15. (Original) The coupled inductor regulator of Claim 12 wherein the at least two conduction switches, the at least two inductors, and the at least two freewheeling switches are connected in a flyback configuration including two flyback regulators each operating at approximately 50% duty cycle, each flyback regulator including;

a conduction switch in communication with a freewheeling switch and an inductor, the conduction switch to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the freewheeling switch

to provide a conduction path during the non-conduction period for current flowing from the output through the inductor to the low side of the source of input voltage.

16. (Original) The coupled inductor regulator of Claim 12 wherein each of the at least two inductors has a quantity of turns, and a turns ratio of the turns for each pair of series inductors is selected to set a voltage ratio of the output voltage divided by the input voltage.

17. (Original) The coupled inductor regulator of Claim 16 wherein the at least two inductors each have approximately an equal quantity of turns such that the output voltage is approximately equal to one-fourth of the input voltage; and

wherein the at least two conduction switches, pairs of two series inductors, and the at least two freewheeling switches are connected in a buck configuration, the buck configuration including two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a conduction switch in communication with a freewheeling switch and a pair of series inductors, the conduction switch to communicate current during a conduction period from the source of input voltage through the pair of series inductor to the output, the freewheeling switch to

provide a conduction path during the non-conduction period for current flowing through one of the series inductors to the output.

18. (Original) The coupled inductor regulator of Claim 16 wherein the series inductors include a first inductor in communication with one of the conduction switches and a second inductor in communication with the output;

the turns ratio of the series inductors is defined as a quantity of turns of the first inductor divided by a quantity of turns of the second inductor; and

wherein the turns ratio of the series inductors is approximately equal to one-half such that the voltage ratio is approximately one-third.

19. (Original) The coupled inductor regulator of Claim 1 wherein the freewheeling switches include synchronous rectifiers.

20. (Original) The coupled inductor regulator of Claim 1 wherein the drive signals include multi-level switching to reduce switching losses.

21. (Original) The coupled inductor regulator of Claim 1 included in a power system, the power system including a low dropout regulator having a first output, the first output being the input voltage to the coupled inductor regulator; and

a feedback signal connected from the output voltage of the coupled inductor regulator to the low dropout regulator, the low dropout regulator to regulate the first output in response to the feedback signal.

22. (Original) The coupled inductor regulator of Claim 1 wherein the common core is made from a high permeability material.

23. (Original) The coupled inductor regulator of Claim 22 wherein the common core is made from a ferrite.

24.-74. (Cancelled)

75. (Original) A coupled inductor regulator for converting energy from a source of input voltage to an output having an output voltage, comprising:

at least two means for conduction switching to controllably conduct energy from the source of input voltage to the output;

at least two inductors in communication with the at least two means for conduction switching, the at least two inductors wound together on a common core and each inductor having a polarity such that DC currents in the inductors cancel each other, the inductors having a coefficient of coupling approximately equal to one;

at least two means for freewheeling switching in communication with the at least two conduction switching means to provide a path for current during non-conduction periods; and

means for generating drive signals, the drive signals each having a duty cycle of approximately 50%, and the drive signals to control the at least two conduction switching means.

76. (Original) The coupled inductor regulator of Claim 75 wherein the coefficient of coupling is approximately at least 0.99.

77. (Original) The coupled inductor regulator of Claim 75 wherein the at least two conduction switching means, the at least two inductors, and the at least two freewheeling switching means are connected in a buck configuration such that the output voltage is approximately one-half the amplitude of the input voltage.

78. (Previously Presented) The coupled inductor regulator of Claim 77 wherein the buck configuration includes two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a means for conduction switching in communication with a means for freewheeling switching and an inductor, the conduction switching means to communicate current during a conduction period from the source of input voltage through the inductor to the output, the freewheeling switching means to provide a conduction path during the non-conduction period for current flowing through the inductor to the output.

79. (Original) The coupled inductor regulator of Claim 75 wherein the at least two means for conduction switching, the at least two inductors, and the at least two means for freewheeling switching are connected in a boost configuration such that the output voltage is approximately twice the amplitude of the input voltage.

80. (Original) The coupled inductor regulator of Claim 79 wherein the boost configuration includes two boost regulators each operating at approximately 50% duty cycle, each boost regulator including;

a means for conduction switching in communication with a means for freewheeling switching and an inductor, the means for conduction switching to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing from the high side of the source of input voltage through the inductor to the output.

81. (Original) The coupled inductor regulator of Claim 75 wherein the at least two means for conduction switching, the at least two inductors, and the at least two means for freewheeling switching are connected in a 1:-1 configuration such that the output voltage is approximately a negative of the input voltage.

82. (Original) The coupled inductor regulator of Claim 81 wherein the 1:-1 configuration includes two flyback regulators each operating at approximately 50% duty cycle, each flyback regulator including;

a means for conduction switching in communication with a means for freewheeling switching and an inductor, the means for conduction switching to communicate current during a conduction period from the a high side of the source of input

voltage through the inductor to a low side of the source of input voltage, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing from the output through the inductor to the low side of the source of input voltage.

83. (Original) The coupled inductor regulator of Claim 75 wherein at least one of the at least two means for conduction switching includes independently controllable parallel switches.

84. (Original) The coupled inductor regulator of Claim 75 wherein the output voltage supplies power to a load; and

further comprising means for frequency generating to generate a clock signal having an operating frequency, the drive signals synchronous to the clock signal, and the operating frequency controllable in response to changes in the load.

85. (Original) The coupled inductor regulator of Claim 84 wherein the changes in the load include output current changes and output voltage changes.

86. (Original) The coupled inductor regulator of Claim 75 wherein each of the at least two inductors includes a pair of

series inductors, each pair having a common node between the series inductors; and

each of the at least two means for conduction switching in communication with the common node of a corresponding pair of series inductors.

87. (Original) The coupled inductor regulator of Claim 86 wherein the at least two means for conduction switching, pairs of series inductors, and the at least two means for freewheeling switching are connected in a buck configuration, the buck configuration including two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a means for conduction switching in communication with a means for freewheeling switching and the pair of series inductors, the means for conduction switching to communicate current during a conduction period from the source of input voltage through the pair of series inductors to the output, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing through one of the series inductors to the output.

88. (Original) The coupled inductor regulator of Claim 86 wherein the at least two means for conduction switching, the at least two inductors, and the at least two means for freewheeling

switching are connected in a boost configuration including two boost regulators each operating at approximately 50% duty cycle, each boost regulator including;

a means for conduction switching in communication with a means for freewheeling switching and an inductor, the means for conduction switching to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of input voltage, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing from the high side of the source of input voltage through the inductor to the output.

89. (Original) The coupled inductor regulator of Claim 86 wherein the at least two means for conduction switching, the at least two inductors, and the at least two means for freewheeling switching are connected in a flyback configuration including two flyback regulators each operating at approximately 50% duty cycle, each flyback regulator including;

a means for conduction switching in communication with a means for freewheeling switching and an inductor, the means for conduction switching to communicate current during a conduction period from the a high side of the source of input voltage through the inductor to a low side of the source of

input voltage, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing from the output through the inductor to the low side of the source of input voltage.

90. (Original) The coupled inductor regulator of Claim 86 wherein each of the at least two inductors has a quantity of turns, and a turns ratio of the turns for each pair of series inductors is selected to set a voltage ratio of the output voltage divided by the input voltage.

91. (Original) The coupled inductor regulator of Claim 90 wherein the at least two inductors each have approximately an equal quantity of turns such that the output voltage is approximately equal to one-fourth of the input voltage; and wherein the at least two means for conduction switching, pairs of two series inductors, and the at least two means for freewheeling switching are connected in a buck configuration, the buck configuration including two buck regulators each operating at approximately 50% duty cycle, each buck regulator including;

a means for conduction switching in communication with a means for freewheeling switching and a pair of series inductors, the means for conduction switching to communicate

current during a conduction period from the source of input voltage through the pair of series inductor to the output, the means for freewheeling switching to provide a conduction path during the non-conduction period for current flowing through one of the series inductors to the output.

92. (Original) The coupled inductor regulator of Claim 90 wherein the series inductors include a first inductor in communication with one of the at least two means for conduction switching and a second inductor in communication with the output;

the turns ratio of the series inductors is defined as a quantity of turns of the first inductor divided by a quantity of turns of the second inductor; and

wherein the turns ratio of the series inductors is approximately equal to one-half such that the voltage ratio is approximately one-third.

93. (Original) The coupled inductor regulator of Claim 75 wherein the at least two means for freewheeling switching include synchronous rectifiers.

94. (Original) The coupled inductor regulator of Claim 75 wherein the drive signals include multi-level switching to reduce switching losses.

95. (Original) The coupled inductor regulator of Claim 75 included in a power system, the power system including means for low dropout regulating having a first output, the first output being the input voltage to the coupled inductor regulator; and
a feedback signal connected from the output voltage of the coupled inductor regulator to the means for low dropout regulating, the means for low dropout regulating to regulate the first output in response to the feedback signal.

96. (Original) The coupled inductor regulator of Claim 75 wherein the common core is made from a high permeability material.

97. (Original) The coupled inductor regulator of Claim 96 wherein the common core is made from a ferrite.

98.-154. (Cancelled)

155. (Original) A coupled inductor regulator for converting energy from a source of input voltage to an output having an output voltage, comprising:

at least two phase signals to control a conduction time;

at least two drivers, responsive to the at least two phase signals, to conduct energy from the source of input voltage;

a lattice network of coupled inductors in communication between the at least two drivers and the output, the lattice network having N stages wherein N is at least one, pairs of inductors within each of the stages each having a coefficient of coupling approximately equal to one;

the phase signals each having a duty cycle of approximately 100%/2N; and

the output voltage approximately equal to the input voltage divided by 2N.

156. (Original) The coupled inductor regulator of Claim 155 wherein the at least two phase signals have a quantity approximately equal to 2N.

157. (Original) The coupled inductor regulator of Claim 155 wherein the at least two drivers have a quantity approximately equal to 2N.

158. (Original) The coupled inductor regulator of Claim 155 wherein the pairs of inductors of a stage of the lattice network are in communication with an inductor of a previous stage of the lattice network such that each stage of the lattice network has twice as many inductors as the previous stage.

159. (Original) The coupled inductor regulator of Claim 155 wherein the pairs of inductors are each wound on corresponding single magnetic core structures.

160. (Original) The coupled inductor regulator of Claim 155 wherein N is equal to two and the output voltage is approximately equal to one-fourth of the input voltage.

161. (Original) The coupled inductor regulator of Claim 160 wherein the pairs of inductors are each wound on corresponding single magnetic core structures.

162. (Original) The coupled inductor regulator of Claim 160 wherein the phase signals are arranged in a timing sequence selected from a group consisting of sequential and alternating.

163. (Original) The coupled inductor regulator of Claim 162 an intermediate frequency of the lattice network with the alternating timing sequence is greater than the intermediate frequency of the lattice network with the sequential timing sequence.

164. (Original) A coupled inductor regulator for converting energy from a source of input voltage to an output having an output voltage, comprising:

at least two phase signals to control a conduction time;

at least two means for conducting, responsive to the at least two phase signals, to conduct energy from the source of input voltage;

a lattice network of coupled inductors in communication between the at least two means for conducting and the output, the lattice network having N stages wherein N is at least one, pairs of the coupled inductors within each of the stages each having a coefficient of coupling approximately equal to one;

the phase signals each having a duty cycle of approximately 100%/2N; and

the output voltage approximately equal to the input voltage divided by 2N.

165. (Original) The coupled inductor regulator of Claim 164 wherein the at least two phase signals have a quantity approximately equal to 2N.

166. (Original) The coupled inductor regulator of Claim 164 wherein the at least two means for conducting have a quantity approximately equal to 2N.

167. (Original) The coupled inductor regulator of Claim 164 wherein the pairs of inductors of a stage of the lattice network are in communication with an inductor of a previous stage of the lattice network such that each stage of the lattice network has twice as many inductors as the previous stage.

168. (Original) The coupled inductor regulator of Claim 164 wherein the pairs of inductors are each wound on corresponding single means for magnetic coupling.

169. (Original) The coupled inductor regulator of Claim 164 wherein N is equal to two and the output voltage is approximately equal to one-fourth of the input voltage.

170. (Original) The coupled inductor regulator of Claim 169 wherein the pairs of inductors are each wound on corresponding single means for magnetic coupling.

171. (Original) The coupled inductor regulator of Claim 169 wherein the phase signals are arranged in a timing sequence selected from a group consisting of sequential and alternating.

172. (Original) The coupled inductor regulator of Claim 171 an intermediate frequency of the lattice network with the alternating timing sequence is greater than the intermediate frequency of the lattice network with the sequential timing sequence.

173.-186. (Cancelled)

187. (Previously Presented) The coupled inductor regulator of Claim 1 wherein a combined conduction time of said at least two conduction switches approaches but is less than 100%.

188. (Previously Presented) The coupled inductor regulator of Claim 1 wherein said at least two conduction switches include a first conduction switch that receives a first drive signal and a second conduction switch that receives a second drive signal, wherein said at least two freewheeling switches include a first freewheeling switch that receives said second drive signal and a second freewheeling switch that receives said first drive signal, and wherein said first and second drive signals are the same signal with a phase offset that is equal to 360 degrees divided by a number of said conduction switches.

189.-239. (Cancelled)

240. (Previously Presented) The coupled inductor regulator of Claim 1 wherein a first conduction time of one of said conduction switches is separated from a second conduction time of another of said conduction switches by non-conduction time, wherein a duration of said non-conduction time is substantially less than a duration of both said first conduction time and said second conduction time.

241. (Previously Presented) The coupled inductor regulator of Claim 75 wherein a first conduction time of one of said at least two means for conduction switching is separated from a

second conduction time of another of said at least two means for conduction switching by non-conduction time, and wherein a duration of said non-conduction time is substantially less than a duration of both said first conduction time and said second conduction time.

242. (Previously Presented) The coupled inductor regulator of Claim 75 wherein said at least two means for conduction switching have a combined conduction time that approaches but is less than 100%.

243. (Previously Presented) The coupled inductor regulator of Claim 75 wherein one of said at least two means for conduction switching receives a first drive signal, another of said at least two means for conduction switching receives a second drive signal, one of said at least two means for freewheeling switching receives said second drive signal, and another of said at least two means for freewheeling switching receives said first drive signal, and wherein said first and second drive signals are the same signal with a phase offset that is equal to 360 degrees divided by a number of said conduction switches.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None

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